University of Vermont | Gund Institute for Environment

Yolanda Chen (1,4), Alicia Mastretta-Yanes (2,7), Daniel Tobin (1,4), Mauricio Bellon (3,8), Eric von Wettberg (1,4), Angelica Cibrian Jaramillo (5), Sofia Monroy-Sais (6), Ana Wegier (6)

1.University of Vermont, USA, 2.CONABIO, Mexico, 3.Arizona State University, USA, 4.Gund Institute for Environment, University of Vermont, USA, 5.Naturalis Biodiversity Center, Netherlands, 6.Universidad Nacional Autónoma de México, Mexico, 7.Royal Botanical Gardens, Kew, United Kingdom, 8.Swette Center for Sustainable Food Systems

Valuing Traditional Seed Systems

Farmer seed saving provides critical "evosystem services"

Summary

The stability of the world's food supply is dependent upon the genetic diversity retained in traditional seed systems.

Traditional, or informal, seed systems are threatened globally by the lack of supportive policies for small-scale farmers who save seed. For millennia, farmers have saved seeds from their harvests, thereby adapting crop varieties to local conditions and generating the extraordinary diversity seen among crop landraces (Fig.1). Landraces possess remarkable adaptations for growing in stressful environments and collectively account for the majority of crop genetic diversity, their conservation is critical for sustaining the world's food supply. In centers of origin, where crops were domesticated, farmer seed saving and seed exchanges within traditional seed systems generate evosystem services, which are the benefits humans derive from historical, contemporary, and future evolutionary processes associated with these seed systems (Fig. 1).

Key Terms

Evosystem services: *Current and future benefits for society derived from evolutionary processes*

Landrace: *Domesticated plant varieties, adapted to local climate and location*

Traditional (Informal) seed system: *Seeds collected by farmers, distributed by farmer-to-farmer networks for planting.*

Formal seed system: *Seeds that are bred centrally by public or private breeders, usually distributed commercially or by public extension services.*

Current agricultural and marketing policies prioritize formal seed systems, causing the erosion of evosystem services and crop genetic diversity.

High-yielding varieties generated by professional breeders are often protected by intellectual property rights that reinforce the exclusivity of seeds as private goods, which contributes to market consolidation in the formal seed system, further endangering traditional seed systems and the associated evosystem services. Proactive policy making should consider the imbalance of economic and political power to center equality and equity in the access and benefit-sharing of agrobiodiversity.

To continue generating adaptive diversity, a key evosystem service, farmers need to maintain landrace crops to adapt them to changing climates.

Although crop genetic diversity is considered a global public good, the costs of growing landraces are shouldered by individual farmers. Farmers grow crops under increasingly unpredictable climatic conditions, exposing them to crop loss and food insecurity. If small-scale farmers stop growing landraces, we will lose critically important evosystem services and endanger the adaptability of our future food supply.

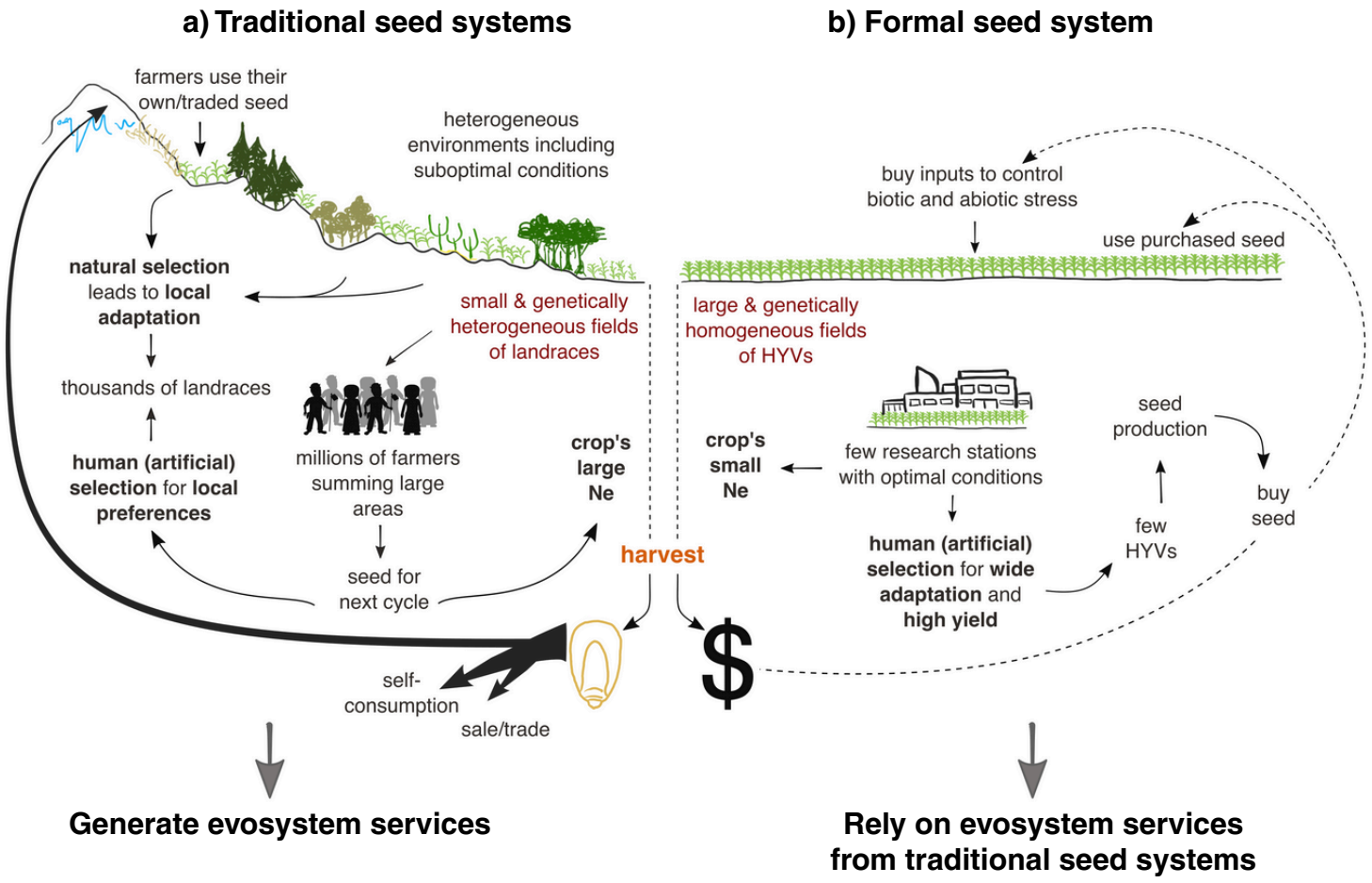


Figure 1: Seed selection and evolutionary processes differ between traditional and formal seed systems. In formal seed systems high-yielding varieties (HYVs) are selected by professional breeders under ideal and homogenous fertile conditions. In traditional seed systems, many small-scale farmers save seed based on the crops that perform the best locally. Collectively, farmer seed saving activities generate evosystem services that foster genetic diversity and agroecosystem sustainability.

University of Vermont | Gund Institute for Environment

How Investment and Policy Can Protect Traditional Seed Systems

(1) Maintain farmers' rights to save and share seeds and knowledge with other farmers.
Seed saving and traditional agricultural knowledge should be protected as a basic right for farmers and gardeners. Protections are needed for farmers to grow, save, and share seeds, and knowledge with other farmers without restrictions and on their own volition. These basic rights are important for supporting new genetic diversity to arise and for crops to adapt to local conditions.

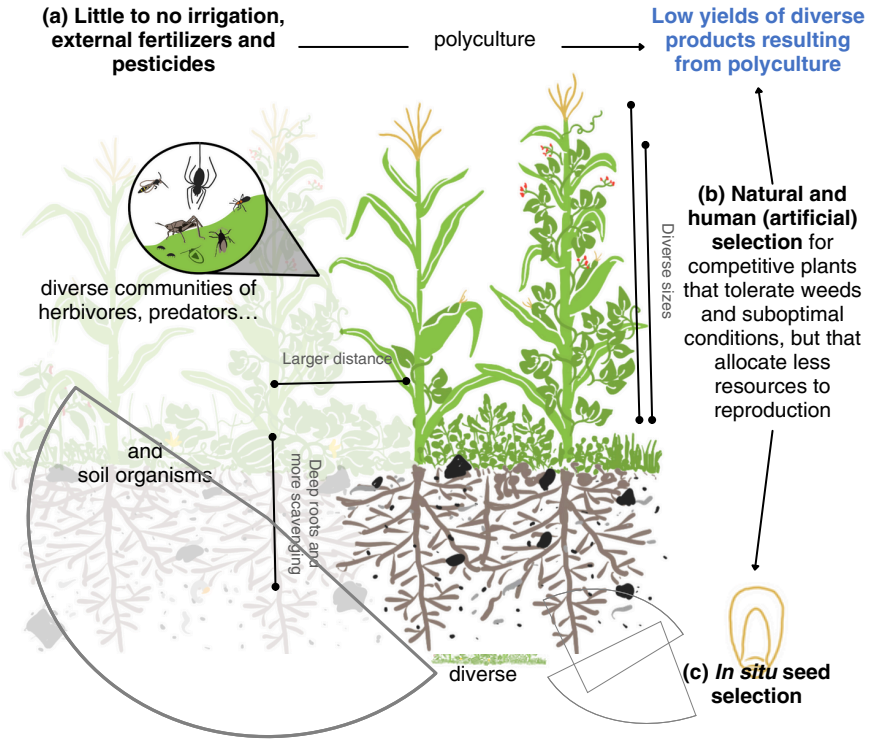
(2) Support traditional seed systems by investing in farmers' livelihoods, especially where crops originate.
Governments, philanthropic organizations, and private entities should increase support for farmers who save seed, especially for small-scale farmers in centers of crop origin where genetic diversity is highest.

Supporting traditional seed systems requires understanding how landrace seeds contribute to farmers' livelihoods. Since traditional seed systems vary according by context, farmer participation is needed to design policies that support farmers effectively and protect their ownership.

(3) Characterize the evosystem services generated by traditional seed systems.
Since only a small percentage of *landraces* have been studied ecologically, more cooperation between researchers and farmers is needed to characterize the evosystem services associated with landrace seeds. Since the expression of traits can vary by environment, it will be important to determine if beneficial crop traits are expressed in new environments. Research would help demonstrate the value of evosystem services, which would bolster public support for traditional seed systems.

(4) Develop equitable Access and Benefit-Sharing (ABS) structure for agrobiodiversity.
Equitable policies should provide material benefits for small-scale farmers who grow, develop, and maintain landraces. These policies are particularly needed when there are exchanges between traditional and formal seed systems because of the unequal access to power, financial resources, and legal knowledge on ABS policies.

University of Vermont | Gund Institute for Environment

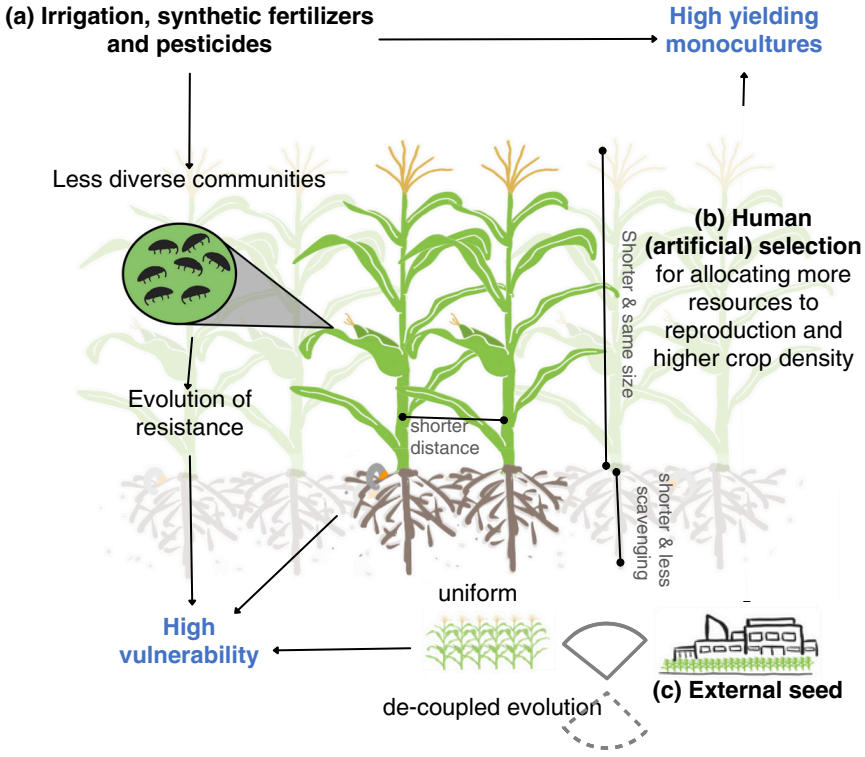


In traditional seed systems, farmers select crop landraces for traits that enable plants to positively interact with other species (e.g. insects and microbes) to meet the plant's nutritional and defense needs (Fig. 2).

Fig. 2: Landrace crops depend on biodiversity to sustain their growth under low input conditions. In milpa polyculture systems, maize, beans, and squash have been selected together with associated insect and microbes to contribute to ecosystem services.

In formal seed systems, professional breeders select "improved" crop varieties for high yields, aiming for a particular appearance under ideal environmental conditions (Fig. 3).

Fig. 3: High-yielding varieties have been bred to be dependent on external inputs to achieve high yields. The system prioritizes high yields, resulting in a monoculture that is low in insect and microbial diversity.



University of Vermont | Gund Institute for Environment

Conclusion

Professionally-bred crops are dependent upon external inputs of fertilizers, pesticides, and irrigation, but less resistant to drought, pests, and nutrient deficiencies. Although breeders depend upon landraces to introduce the genetic diversity needed to increase stress tolerance in commercial crop varieties, the traditional seed systems that produce landraces urgently need support. Our future food supply depends upon a diversity of crop varieties that can grow under a wide range of environmental conditions with minimal inputs.

Farmer-led traditional seed systems provide evosystem services that are essential for the security and diversity of the globe's current and future seed supply.

Agricultural evosystem services are the societal benefits derived from small-scale farmer seed saving. Small-scale farmers who save seeds and engage in farmer-to-farmer exchange provide critical evosystem services necessary to adapt food production to a rapidly changing climate.

Currently, seed saving is declining at an alarming rate due to inadequate policy support for traditional seed systems. Effective access, investment, and benefit-sharing mechanisms are essential to ensure that farmers can continue managing crops to adapt to environmental changes as well as provide sources for future formal seed systems.

Figures and Ideas Sourced From:

Human Management of Ongoing Evolutionary Processes in Agroecosystems. Mastretta-Yanes, A., D. Tobin, M. R. Bellon, E. von Wettberg, A. Cibrián-Jaramillo, A. Wegier, A. S. Monroy-Sais, N. Gálvez-Reyes, J. Ruiz-Arocho*, and Y. H. Chen. 2024. Plants, People, Planet 6(6):1190-1206 https://doi.org/10.1002/ppp3.10521.

Contact: *Professor Yolanda Chen, University of Vermont yolanda.chen@uvm.edu*